

## Remarks

Claims 1-26 are currently pending in this application. Claims 19-26 are new.

Claims 8, 9, 11, 12, 14 and 16 are cancelled. Claim 15 is currently amended.

## Amendments to the Specification

5 Paragraph 0001 of the specification has been amended to show the current status of related applications as requested by the Examiner.

## Double patenting rejection

In the current office action, the Examiner states that claims 1-3 are substantial  
duplicates of Claims 5-7, and that as such Claims 5-7 would be subject to a double  
10 patenting objection if Claims 1-3 were allowable. The Applicant traverses this objection.

### Claim 1 recites:

1. *A method of reducing the number of times a tree data structure is rebalanced comprising the steps of:*  
15 (a) *allowing a sub-tree of the data tree structure to grow unbalanced to a threshold level greater than one; and*  
(b) *rebalancing the data tree structure when the threshold level is reached.*

### Claim 5 recites:

5. *A method of deferring the rebalancing of a tree data structure comprising the steps of:*  
20 (a) *allowing a sub-tree of the tree data structure to grow unbalanced to a length greater than one; and*  
(b) *rebalancing the tree data structure when the length of the sub-tree reaches a threshold level.*

25 In the specification as filed there are at least two distinct methods of determining when a tree should be rebalanced. In a first case, the depth of a tree is monitored and rebalancing occurs when this depth reaches a threshold level. In a second case, the change in length of a sub-tree is monitored and rebalancing occurs when this sub-tree

length reaches the threshold level. See, for example, paragraphs 0050, 0051 and 0054 of the specification as filed.

Claims 1 and 5 differ in that Claim 5 recites that the length of the sub-tree is the length that is compared with the threshold level, unlike Claim 1, Claim 5 specifically  
5 recites that it is the length of the *sub-tree* that is compared with the threshold level.

Claim 1 is therefore broader than Claim 5 in that Claim 1 may cover instances wherein the length monitored is that of the entire tree rather than merely the sub-tree. Because the scope of Claims 1 and 5 are different, it is the position of the Applicant that Claims 1 and 5 are not substantially duplicative.

10        **Claims 1-18 were rejected under 35 U.S.C. 102(b) as being anticipated by Larsen et al. ("B-trees With Relaxed Balance").**

**Regarding Claim 1,**

**Claim 1 recites:**

- 15        *1. A method of reducing the number of times a tree data structure is rebalanced comprising the steps of:*  
              *(a) allowing a sub-tree of the data tree structure to grow unbalanced to a threshold level greater than one; and*  
              *(b) rebalancing the data tree structure when the threshold level is reached.*

20        In rejecting Claim 1, the Examiner states "Larsen teaches the invention as claimed, including a method of reducing the number of times a tree data structure is rebalanced (§1) comprising the steps of: (a) allowing a sub-tree of the data tree structure to grow unbalanced to a threshold level greater than one (§§1,3); and rebalancing the data tree structure when the threshold level is reached (§4)." The Applicant traverses this  
25        statement.

Specifically, the Applicant is unable to identify any teaching within the cited sections of Larsen indicating that rebalancing is to occur when a “*threshold level [greater than one and to which a tree structure grows] is reached.*” Rather, Larsen teaches that rebalancing should occur based on “working hours” (page 196 col. 2 lines 32-35), or such that there is “a constant number of operations [insertions and deletions] per update” (page 196 col. 2 lines 31-32). Neither of these two factors appear to be related to the “*threshold level*” to which “the data tree structure ... grow” as recited in Claim 1. The Applicant, therefore, requests that the Examiner specifically point out these teachings in Larsen or allow Claim 1 and those claims that depend therefrom.

**Regarding Claim 2,**

**Claim 2 recites:**

2. *The method of claim 1 wherein the threshold level is  $\log_2 n$  for a tree data structure having about  $n$  nodes.*

The Applicant believes that Claim 2 is allowable for at least the same reasons as Claim 1, from which it depends.

In rejecting Claim 2, the Examiner states “Larsen teaches the invention as claimed, including the method of Claim 1 wherein the threshold level is  $\log_2 n$  for a tree data structure having about  $n$  nodes (§§3, 5).” The Applicant traverses this statement.

As discussed above with respect to Claim 1, Larsen teaches that rebalancing should occur based on “working hours” (page 196 col. 2 lines 32-35), or such that there is “a constant number of operations [insertions and deletions] per update” (page 196 col. 2 lines 31-32). Neither of these two factors appear to be related to the “*the threshold level is  $\log_2 n$  for a tree data structure having about  $n$  nodes*” as recited in Claim 2. The

Applicant, therefore, requests that the Examiner specifically point out such teaching, or allow Claim 2.

Further, §3 of Larsen does not appear to teach a logarithmic function much less a logarithmic function used as a threshold level for determining when rebalancing should occur. Likewise, §5 of Larsen does teach the use of logarithmic functions for determining when rebalancing should occur. In Corollary 3 (page 199) a function  $\log_a(N/2)$  is used to calculate a limit of the “relaxed height of any node in a relaxed (a,b)-tree.” In Theorem 4 (page 199) a function  $k(\lceil \log_a(N/2) \rceil + 1)$  is used to determine the maximum number of operations required to rebalance a standard (a,b)-tree. Neither of these functions appear to teach use of a logarithmic function as a threshold level for determining when rebalancing should occur. Further, the functions taught in Larsen are  $\log_a(N/2)$  rather than  $\log_2(N)$  as recited in Claim 2. Therefore, the Applicant requests that the Examiner specifically point out teachings of all the limitations of Claim 2, or allow Claim 2.

**Regarding Claim 3,**

**Claim 3 recites:**

*3. The method of claim 1 wherein the threshold level is a constant number of levels greater than a level of a balanced portion of the tree data structure.*

The Applicant believes that Claim 3 is allowable for at least the same reasons as Claim 1, from which it depends.

Regarding Claim 3, the Examiner states “Larsen teaches the invention as claimed, including the method of claim 1 wherein the threshold level is a constant number of levels greater than a level of a balanced portion of the tree data structure (§§3, 5).” The

Applicant traverses this statement.

As discussed above with respect to Claim 1, Larsen teaches that rebalancing should occur based on “working hours” (page 196 col. 2 lines 32-35), or such that there is “a constant number of operations [insertions and deletions] per update” (page 196 col. 2 lines 31-32). Neither of these two factors appear to be related to the “*a constant number of levels greater than a level of a balanced portion of the tree data structure*” as recited in Claim 3. The Applicant, therefore, requests that the Examiner specifically point out such teaching, or allow Claim 3.

**Regarding Claim 4,**

**Claim 4 recites:**

4. *The method of claim 1 wherein the step of rebalancing the tree data structure further comprises:*
- (a) developing first and second sets of rebalancing operation tasks, the first set of operation tasks operable to effect a first set of element state transitions and the second set of operation tasks operable to effect a second set of element state transitions, the first and second set of element state transition being distinct one from the other;*
  - (b) performing the first set of operation tasks in a first phase; and*
  - (c) performing the second set of operation tasks in a second phase.*

The Applicant believes that Claim 4 is allowable for at least the same reasons as Claim 1, from which it depends.

In rejecting Claim 4 the Examiner states

Larsen teaches the invention as claimed, including the method of claim 1 wherein the step of rebalancing the tree data structure further comprises:

- (a) developing first and second sets of rebalancing operation tasks, the first set of operation tasks operable to effect a first set of element state transitions and the second set of operation tasks operable to affect a second set of element state transitions, the first and second set of element state transition being distinct from the other (§4, “Split” and “Compress”);
- (b) performing the first set of operation tasks in a first phase (§5); and
- (c) performing the second set of operation tasks in a second phase (§5).

The Applicant traverses this statement.

Specifically, the Applicant is unable to identify any teaching within the cited art that the two operations cited by the Examiner is executed in “a first phase” and “a second phase” of rebalancing. Specifically, the Applicant is unable to identify any teaching that the “Split” and “Compress” operations cited by the Examiner are performed in different phases. The Applicant, therefore, requests that the Examiner specifically point out such teaching or allow Claim 4.

**Regarding Claims 5-7,**

It is the Applicant’s position that Claims 5-7 are allowable for the same reasons discussed above with respect to Claims 1-3.

**Regarding Claim 10,**

It is the Applicant’s position that Claim 10 is allowable for the same reasons discussed above with respect to Claims 1 and 4.

**Regarding Claims 13 and 15,**

It is the Applicant’s position that Claim 13 and amended Claim 15 are allowable for the same reasons discussed above with respect to Claim 8. Further, amended Claim 15 is allowable as the result of new limitations introduced through amendment.

**Regarding Claim 17,**

**Claim 17 recites:**

17. *A method of deferring the rebalancing of a tree data structure comprising the steps of:*
- (a) tracking the performance of operations upon the tree data structure; and*
  - (b) rebalancing the tree data structure when an unbalanced sub-tree of the tree data structure reaches a threshold level greater than one, the rebalancing further comprising creating a first set of rebalancing operation tasks, the first set of rebalancing operation tasks being characterized by navigation of the tree data structure using at least an existing link, creating a second set of rebalancing operation tasks, the second set of rebalancing operation tasks being different from the first set of rebalancing operation tasks and being characterized by location of elements within the tree data structure using*

*at least one pointer created by the first set of rebalancing operation tasks, and performing at least one operation task of the first set of rebalancing operation tasks in a first phase and at least one of the second set of rebalancing operation tasks in a second phase.*

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The Applicant believes that Claim 17 is allowable for at least the same reasons as Claim 1.

In rejecting Claim 17 the Examiner cites “§4, ‘Split’” as teaching “*first set of rebalancing operation tasks being characterized by navigation of the tree data structure using at least an existing link.*” The Applicant has examined this citation and is unable to identify any teaching that the “split” operation is characterized by “*by navigation of the tree data structure using at least an existing link,*” as recited in Claim 17. The Applicant, therefore, requests that the Examiner specifically point out such teaching or allow Claim 17.

15 Further, the Examiner cites “§4, Compress” as teaching “*the second set of rebalancing operation tasks being different from the first set of rebalancing operation tasks and being characterized by location of elements within the tree data structure using at least one pointer created by the first set of rebalancing operation tasks.*” The Applicant has examined this citation and is unable to identify any teaching that the “compress” operation is “*characterized by location of elements within the tree data structure using at least one pointer created by the first set of rebalancing operation tasks,*” (emphasis added) as recited in Claim 17. The Applicant, therefore, requests that the Examiner specifically point out such teaching or allow Claim 17.

Regarding Claim 18,

25 Claim 18 recites:

18. A method of deferring the rebalancing of a tree data structure comprising the steps of:

- (a) tracking the performance of operations upon the tree data structure; and
- (b) rebalancing the tree data structure when an unbalanced sub-tree of the tree data structure reaches a threshold level greater than one, the rebalancing further comprising executing simultaneous rebalancing operations on the tree data structure including performing any first phase operation task of each of the simultaneous rebalancing operations in a first phase using parallel processes, developing a set of serial rebalancing operations during the first phase, and performing any second phase operation task of each of the simultaneous rebalancing operations in a second phase, the second phase operation task having at least one of the set of serial rebalancing operations.

In rejecting Claim 18, the Examiner cites “§5” as teaching “*first phase operation task of each of the simultaneous rebalancing operations,*” as recited in Claim 18. The Applicant has examined this citation and is unable to identify any teaching of a rebalancing operation having a “*first phase operation task.*” Specifically, the “Split” and “Compress” operations are not taught to each include first phases. The Applicant, therefore, requests that the Examiner specifically point out such teaching or allow Claim 18.

Further, the Examiner cites “§4, ‘Split’” as teaching “*developing a set of serial rebalancing operations during the first phase,*” as recited in Claim 18. The Applicant has examined this citation and is unable to identify any teaching of “*developing a set of serial rebalancing operations,*” within the cited art. Specifically, it is unclear to the Applicant which operations the Examiner believes are developed, much less what constitutes separate phases in Larsen. For example, if for the sake of argument, the “Split” and “Compress” operations were to be considered separate phases, there does not appear to be further development of rebalancing operations during these operations/phases. “Compress” operations are not developed during execution of the “Split” operation. The



Applicant, therefore, requests that the Examiner specifically point out such teaching or allow Claim 18.

**Regarding New Claims 19-26:**

New Claims 19-26 are added to the application in order to claim further aspects of the invention. Support for Claims 19-26 can be found at the following locations in the specification as filed, among others:

19. (New) *A method of rebalancing a tree data structure (Page 37 lines 14 and 15), the method comprising:*

*allowing a sub-tree of the tree data structure to grow unbalanced until a*

*threshold level is reached; (Page 25 lines 11-14)*

*developing a first set of rebalancing operation tasks, (Page 5 line 5) the first set of operation tasks operable in parallel (Claim 18) on one or more unlocked nodes (Page 5 line 6) of the tree data structure during a first phase of the rebalancing (Page 5 line 5);*

*developing a second set of rebalancing operation tasks (Page 5 lines 10-12)*

*during execution of the first set of rebalancing operation (Page 15 lines 3-8; Page 17 lines 13 and 14); and*

*executing the second set of rebalancing operation tasks (Page 5 lines 10-13) during a second phase of the rebalancing (Page 5 lines 10-13).*

20. (New) *The method of claim 19, wherein execution of the second set of rebalancing operation tasks is performed without navigating between nodes of the sub-tree. (Page 16 lines 10-13).*

21. (New) *The method of claim 19, wherein execution of the first set of rebalancing operations includes generating a list of pointers to nodes requiring updating in the second phase of rebalancing. (Page 16 lines 16-24).*

22. (New) *A method of rebalancing a tree data structure, the method comprising:*

5     *allowing a sub-tree of the data tree structure to grow unbalanced until a threshold level is reached;*  
  
*executing a first set of rebalancing operation tasks during a first rebalancing phase, the first rebalancing phase being characterized by navigation between nodes of the sub-tree (Page 9 lines 16-18; Page 15 lines 6 to Page*  
10     *16 line 2); and*

*executing a second set of rebalancing operation tasks during a second rebalancing phase, the second rebalancing phase including navigation to two or more nodes of the sub-tree, the navigation being independent of pointers between nodes of the sub-tree (Page 16 lines 10-13).*

15   23. (New) *The method of claim 22, wherein the first set of rebalancing operation tasks are performed on unlocked nodes of the sub-tree (Page 5 line 6).*

24. (New) *The method of claim 22, wherein the first set of rebalancing operation tasks includes a plurality of operation tasks configured for parallel execution. (Claim 18).*

20   25. (New) *A method of maintaining a tree data structure, the method comprising:*  
  
*allowing the tree data structure to grow unbalanced;*  
  
*performing first set of rebalancing operation tasks during a first rebalancing phase on a plurality of nodes in the tree data structure, the first set of*

*rebalancing operation tasks being configured for execution while the plurality of nodes are unlocked (Page 5 line 6) and for insertion and deletion of nodes (Tables 1 and 2); and*

*performing a second set of rebalancing operation tasks on the plurality of nodes*


5        *in a second rebalancing phase, the second set of rebalancing operation tasks being different than the first set of rebalancing operation tasks and being configured for further operations on the plurality of nodes, the second rebalancing phase occurring after completion of the first rebalancing phase (Tables 1 and 2).*

10    26. (New) *The method of claim 25, wherein the first set of rebalancing operation tasks are performed in parallel (Claim 18).*

Applicant believes that all pending claims are allowable and respectfully requests that the Examiner issue a Notice of Allowance. The Applicant believes that no additional fees are due in this application, as the current number of pending claims is equal to or less than those previously paid for. Should the Examiner have questions, the Applicant's undersigned representative may be reached at the number provided.

Respectfully submitted,  
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